CASE REPORTS

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A Complication of Hysteroscopy: Air Embolism

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Hysteroscopy is an established gynecologic procedure that has been used for the past 20 yr as a diagnostic technique. It is also used therapeutically to remove foreign bodies and intrauterine devices and more recently to treat Asherman's syndrome, excise uterine septa and submucosal myomas, and for endometrial ablation for intractable uterine bleeding. These newer applications use the neodymium:yttrium-aluminum-garnet (Nd:YAG) laser or the urologic resectoscope. We present two cases of air embolism during operative hysteroscopy using the Nd:YAG laser and the resectoscope.

CASE REPORTS

Case 1. Patient 1 was a healthy 35-yr-old woman, ASA Physical Status 1, weighing 65 kg, scheduled for outpatient laser hysteroscopy for menorrhagia. General anesthesia was induced with thiopental, and succinylcholine was used to facilitate tracheal intubation. Anesthesia was maintained with isoflurane, nitrous oxide, and oxygen, and vecuronium was administered for relaxation. Intraoperative monitors included blood pressure cuff, ECG, pulse oximeter, temperature probe, and capnograph. The cervix was dilated, and a dual-channel hysteroscope with attached video camera was inserted into the endometrial cavity. The uterus was distended using lactated Ringer's solution in 5-l bags connected to clear y-type TUR tubing with gravity drainage. A 600-μm bare laser fiber was inserted through the accessory portal. The endometrium was ablated using a combination of "dragging touch" and "nontouch" techniques at powers of 50–65 watts. Intermittently the uterine cavity was drained and redistended. Approximately 30 min into the case "excessive bubbling" was noted within the fluid distending the uterine cavity. Some bubbles had been noted in the tubing of the irrigant solution as bags were changed. The end-tidal CO_2 decreased from 34 to 22 mmHg. The gynecologist discontinued laser ablation and uterine irrigation. One hundred percent oxygen was administered. The patient remained hemodynamically stable; thus, patient position was not changed. The end-tidal CO_2 returned to normal within 3–4 min. A precordial doppler was added as an additional monitor and surgery resumed. Again, the end-tidal CO_2 decreased from 35 to 21 mmHg with a change in the doppler tones characteristic of air embolism. No bubbles had been noted in the tubing. The surgical procedure was discontinued and the lungs were ventilated with 100% oxygen. Again, there were no hemodynamic changes and the end-tidal CO_2 returned to normal within minutes without additional treatment. Neuromuscular blockade was reversed, the trachea was extubated, and the patient was taken to the recovery room awake and subsequently discharged without neurologic or cardiac sequelae.

Case 2. Patient 2 was a 39-yr-old woman, ASA Physical Status 1, weighing 65 kg, scheduled for operative hysteroscopy using a resectoscope for symptomatic uterine fibroids. Following preanesthetic medication with midazolam, glycopyrrolate, *d*-tubocurarine, and droperidol, general anesthesia was induced with thiopental and tracheal intubation facilitated with succinylcholine. Anesthesia was maintained with isoflurane, oxygen, air, and fentanyl, and vecuronium was added for relaxation. Monitors used were a blood pressure cuff, ECG, pulse oximeter, capnograph, precordial doppler, temperature probe, nerve stimulator, and stethoscope. Following cervical dilation a resectoscope was inserted into the uterine cavity. Uterine distention was achieved with 1.5% glycine solution attached to tubing suspended above the patient. Glycine solution was released from the uterus intermittently *via* a port of the resectoscope controlled by the surgeon. A wire loop was placed in the endometrial cavity, and cutting and coagulation modes were used for resection and hemostasis.

After 30 min of surgery, while the uterus was being irrigated using a urologic bulb syringe, the doppler sounds suddenly increased, pulse oximeter readings decreased from 99% to 90%, end-tidal CO_2 decreased from 31 to 17 mmHg, and the blood pressure decreased from 120/80 to 90/60 mmHg. Hysteroscopy was suspended and the lungs were ventilated with 100% oxygen. The end-tidal CO_2 had spontaneously increased to 25 mmHg when an arterial blood gas was drawn and showed a $pH = 7.30$, $Pa_{CO_2} = 43$, $Pa_{O_2} = 267$, and hemoglobin saturation = 98%. The patient's pulse oximeter readings, end-tidal CO_2, and blood pressure returned to baseline within 5 min without additional treatment and hysteroscopy was resumed. A central venous catheter was inserted following an increase in peak ventilatory pressures from 24 to 40 cm water and concern about both intrauterine fluid absorption and further air emboli. No air was aspirated nor were other signs of air embolism noted. The initial central venous pressure was 25 mmHg and plasma sodium was 121 mEq/l, indicating a dilutional hyponatremia and hypervolemia. Treatment was initiated with 10 mg iv furosemide, resulting in a diuresis of approximately 2 l over the next 2 h. The operative hysteroscopy portion of the surgery lasted for 90 min and was followed by a laparotomy for myomectomy, with total surgical time of 150 min. At completion of surgery neuromuscular blockade was reversed and the patient's trachea was extubated without incident in the operating room. The patient was discharged home 2 days later without sequelae.

DISCUSSION

Complications of hysteroscopy result primarily from the media used for distending the uterus. The distending medium for hysteroscopy done as an office procedure is CO_2, although small infusions of dextran 70 are sometimes used to irrigate out blood, mucus, smoke, and de-

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bris.‡* Siegler and Valle[1] warned that intrauterine gas pressures should not exceed 200 mmHg and that CO_2 flow should not exceed 100 ml/min at standard temperature and pressure to avoid air embolus. During operative hysteroscopy a liquid distending medium is used. Uterine distention is achieved by gravity flow or manual pumping of the liquid into the uterus with outflow controlled by an outflow catheter, leakage around the laser or resectoscope, or removal of the instrument from the cervix.[1-3]

With either the Nd:YAG laser or resectoscope, endometrial blood vessels are disrupted and bleeding occurs. A high distending pressure tamponades blood vessels and reduces blood loss.[1,2,4] However, fluid absorption occurs *via* the raw surface of severed venous channels.[5-8]

The possibility of gas embolization from gas under pressure and a denuded endometrium was reported by Loffer[2] and Baggish and Baltoyannis.[3] They noted that the use of a coaxial quartz fiber with sapphire tip on the Nd:YAG laser required a gas or liquid coolant transmitted *via* a sheath to the fiber tip and that introduction of a gas into the distended uterus could pose a risk of embolism. Baggish and Daniell[9] recently reported two deaths from gaseous emboli and cardiovascular collapse in Nd:YAG laser operative hysteroscopies using such sheathed coaxial fibers and sapphire tips cooled with nitrogen and air. Prior to introduction of sapphire tips in 1985, however, bare fibers were used that required no cooling mechanism, and these remain in use.

We report two more cases of air emboli. For laser hysteroscopy our gynecologists use the bare fiber requiring no coolant instead of the coaxial sapphire tip. One possible explanation for our cases is air in the irrigation solution entering open venous sinuses under pressure. Another possible explanation is the venous absorption of some of the bubbles from vaporization of tissue. Gas bubbles, endometrial fragments, blood, and debris occur with laser vaporization and resectoscope coagulation of endometrial tissue and are evacuated from the uterus by the irrigant.[2-4] These bubbles may contain particulates, CO_2, carbon monoxide, and other products of combustion.§ Although they have been observed to wash out of the uterus, it merits investigation whether these bubbles under pressure can pass into the disrupted vasculature of the distended uterus without immediately dissolving in the blood.

Our precautions and recommendations for operative hysteroscopy therefore now include continuous precordial doppler monitoring in addition to end-tidal CO_2 monitoring and pulse oximetry. We do not recommend routine insertion of central venous catheters, but in the event of a suspected embolus not immediately resolving on halting surgery, insertion of such a catheter should be considered along with repositioning the patient in left lateral decubitus position. We also avoid nitrous oxide to prevent enlarging an occult air embolus.[10] Special attention is paid to complete evacuation of air from the irrigation fluid and tubing. Finally, prospective studies using intraoperative transesophageal echocardiography or precordial doppler ultrasound in cases of operative hysteroscopy would be helpful to clarify the risk of gas embolization during this procedure.

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